

IMPACT OF PRE - HARVEST CHEMICAL SPRAY ON YIELD AND YIELD PARAMETERS OF BITTER GOURD (*Momordica charantia* L.) CULTIVARS

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ABSTRACT

The aim of this investigation was to study the effect of pre- harvest chemical spray on growth and yield characters of Bitter gourd cv., CO1, MAHY 101, US 6214, Palee and Roma. There were nine treatments with four chemicals, viz., GA₃(250ppm), GA₃(500ppm), BA(50ppm), BA (100ppm), CaCl₂ (0.25 %), CaCl₂ (0.50 %), Ca (NO₃)₂ (0.50 %), Ca (NO₃)₂ (1.0 %), Control (No spray) were sprayed two times starting at the time of flowering and after fruit set, replicated three times in a Factorial Randomized block design. Results revealed that, application of Gibberellic acid (500 ppm) shows significantly early flowering and CaCl₂ - 0.50 per cent increased fruit length, fruit girth, fruit weight, number of fruits and yield per vine.

KEYWORDS: Bitter Gourd, Cultivars, Chemicals, Yield

INTRODUCTION

The bitter gourd (*Momordica charantia* L.) is one of the most nutritive and commercially important vegetable in India as well as in countries of South –East Asia. The bitter gourd is cultivated throughout India as a vegetable crop during the warm seasons of the year. Among the cucurbitaceous vegetables, bitter gourd fruits are highly nutritive and are relatively high in proteins, minerals and vitamins. The fruits are borne on monoecious climbers with slender stem having pubescent or sub-glabrous leaves. The fruits contain, 83.2 per cent water, 2.9 per cent protein, 1.0 per cent fat, 1.4 per cent mineral matter, 1.7 per cent fiber, 9.8 per cent carbohydrates, 0.05 per cent calcium, 0.14 per cent phosphorus, 9.4 per cent iron and traces of Mg (Aykroyd. 1963).

It has immense medicinal properties due to the presence of beneficial phytochemicals which are known to have antibiotic, antimutagenic, antioxidant, antiviral, antidiabetic and immunity enhancing properties (Grover and Yadav, 2004). A compound known as momordicin and charantin present in the bitter gourd is used in the treatment of diabetes in reducing blood sugar level (Lotlikar *et al.* 1966). The perishable nature of bitter gourd is a definite risk to the traders. Pre-harvest sprays of plant growth regulators and other chemicals are known to be effective in enhancing the growth, yield, quality and shelf-life of vegetables (Katwale and Saraf 1990). Hence, experiments were conducted to study the effect of pre- harvest treatments on growth and yield of bitter gourd.

MATERIALS AND METHODS

The field experiment was conducted during 2013 at college orchard in the Department of Horticulture,

Agricultural College and Research Institute, TNAU, Madurai, to find the suitable Pre-harvest chemicals and their doses on the growth and yield of Bitter gourd cv. C₁ - Roma, C₂ - CO₁, C₃ - MAHY 101, C₄ - US 6214 and C₅ - Palee at a spacing of 2x1.5m. The experiment was laid out in a Factorial Randomized Block Design with four chemicals, viz., T₁ - Gibberellic acid (250 ppm), T₂ - Gibberellic acid (500 ppm), T₃ - Benzyl adenine (50 ppm), T₄ - Benzyl adenine (100 ppm), T₅ - CaCl₂ (0.25 %), T₆ - CaCl₂ (0.50 %), T₇ - Ca (NO₃)₂ (0.50 %), T₈ - Ca (NO₃)₂ (1.0 %), T₉ - Control (No spray) were sprayed two times starting at the time of flower initiation and after fruit set. There were nine treatments replicated thrice. Ten plants were tagged in each treatment for biometric observation. Standard package of practices were followed (TNAU Crop production Guide, 2013). The data were statistically analyzed and interpreted.

RESULTS AND DISCUSSIONS

In any production system, the primary goal is to achieve maximum yield per unit area without affecting the quality. In bitter gourd, the yield is mainly judged by early flowering, increased fruit length, fruit girth, fruit weight, number of fruits and yield per plant. Spraying of chemical substances has made a remarkable effect on fruit yield. The data regarding the effect of pre harvest chemicals spraying on days taken for first flowering of fresh bitter gourd is presented in table 1. The days taken for first flowering were significantly different in various pre harvest chemical treatment and cultivars and their interactions. The results revealed that, the minimum days taken for first flowering was recorded with Pre-harvest spray of gibberellic acid T₂ - GA₃ (500ppm) (36.61). The maximum days taken for first flowering were recorded with T₉ - Control (40.82). For various cultivar treatments the minimum days taken for first flowering was C₃ - MAHY101 (36.24) and the maximum days taken for first flowering is C₂ - Co1 (46.11). The interaction between different chemical treatments and cultivar treatments revealed that the minimum days taken for first flowering was recorded in T₂C₁ (T₂- GA₃ (500ppm), C₁- Roma) (33.45) and the maximum value was recorded in T₉C₂ (T₉ Control, C₂- Co1) (48.26). This might be ascribed to more efficient utilization of food for reproductive growth (flowering and fruit set), higher photosynthetic efficiency and enhanced source to sink relationship of the plant, reduced respiration, enhanced translocation and accumulation of sugars and other metabolites. The findings are in concurrence with the melon fruits responses to various growth regulators (Ouzounidou *et al.*, 2008).

Table 1: Effect of Pre-Harvest Chemical Spray on Days (No's) Taken to First Flowering in Bitter Gourd Cultivars

Treatments	Cultivars					Mean
	C ₁	C ₂	C ₃	C ₄	C ₅	
T ₁	35.71	45.33	35.35	36.85	37.69	38.19
T ₂	33.45	43.92	34.70	34.61	36.38	36.61
T ₃	38.53	46.75	38.17	38.06	39.23	40.15
T ₄	37.72	46.59	35.73	37.93	39.00	39.39
T ₅	36.90	45.96	35.81	36.81	38.13	38.72
T ₆	36.74	45.61	35.45	36.46	37.93	38.44
T ₇	37.58	46.38	36.42	37.75	38.75	39.38
T ₈	37.34	46.20	36.20	37.27	38.54	39.11
T ₉	39.63	48.26	38.37	38.25	39.58	40.82
Mean	37.07	46.11	36.24	37.11	38.36	
	T		C		C x T	
SEd	0.93		0.92		0.88	
CD @ 5%	1.83		1.81		1.73	

The data on the fruit length was significantly influenced by different chemical sprays and cultivar treatments and their interactions. For the chemical treatments the highest fruit length was recorded with T₆ - CaCl₂ (0.50 %) (24.85cm) and the lowest fruit length was recorded in T₉ - control (20.15 cm). While different cultivar treatments the highest fruit length was recorded in C₂ - Co1 (24.48 cm) and the lowest was recorded in C₄ - US 6214 (19.95 cm). The interaction between different chemical sprays and cultivars, the highest fruit length was recorded in T₆ C₂ (T₆ - CaCl₂ (0.50 %), C₂ - Co1) (26.73 cm) and the cultivar treatment T₆ C₅ - Palee (25.52 cm) on par with T₆ C₂ and the lowest value was recorded in T₉ C₄ (T₉ - control, C₄ - US 6214) (17.13 cm). Spraying of calcium chloride might have increased the fruit length Vijayaraghavan (2004).

Table 2: Effect of Pre-Harvest Chemical Spray on Fruit Length (Cm) of Bitter Gourd Cultivars

Treatments	Cultivars					
	C ₁	C ₂	C ₃	C ₄	C ₅	Mean
T ₁	23.00	24.13	20.83	19.68	23.42	22.21
T ₂	23.43	24.47	21.00	20.42	23.86	22.64
T ₃	22.66	23.79	20.36	18.00	21.68	21.30
T ₄	22.90	24.00	20.64	19.20	22.06	21.76
T ₅	24.32	25.16	22.10	21.26	24.28	23.42
T ₆	25.96	26.73	23.86	22.17	25.52	24.85
T ₇	23.68	24.90	21.21	20.61	24.00	22.88
T ₈	24.12	25.00	21.63	21.10	24.16	23.20
T ₉	21.07	22.11	20.03	17.13	20.40	20.15
Mean	23.46	24.48	21.30	19.95	23.26	
	T		C		C x T	
SEd	0.72		0.53		0.43	
CD @ 5%	1.51		1.11		0.85	

The fruit girth revealed that the various chemical sprays, cultivar treatments and their interactions had a significant effect. Among the different pre harvest chemicals T₆ - CaCl₂ (0.50 %) (15.98cm) recorded highest fruit girth and the lowest was recorded in T₉ - Control (12.39 cm). Considering the different cultivars the highest fruit girth was recorded in C₅ - Palee (14.16 cm) and the lowest value was recorded in C₂- Co1 (12.83 cm). Regarding interaction of different chemical sprays and cultivars the maximum fruit girth was recorded in T₆ C₅ (T₆ - CaCl₂ (0.50 %), C₅ - Palee) (18.41 cm) and the lowest value was recorded in T₉ C₂ (T₉ - Control, C₂- Co1) (11.23 cm). Spraying of calcium in the form of CaCl₂ 0.05 per cent was found to improve the flesh thickness. This suggests that flesh thickness and increased chelate soluble pectate fractions in the cell walls are both important in enhancing firmness (Conway *et al.* 1992) retention. This may be due to the complex effect Ca has on the tissues. Other factors such as Ca effects on cell membrane function or integrity were observed in Ca treated fruits. These results derive support from the earlier works of Subbiah and Rani Perumal (1994) in tomato and Toivonen and Bowen (1999) in bell pepper.

Table 3: Effect of Pre-Harvest Chemical Spray on Fruit Girth (Cm) of Bitter Gourd Cultivars

Treatments	Cultivars					
	C ₁	C ₂	C ₃	C ₄	C ₅	Mean
T ₁	13.00	12.61	13.38	13.78	16.20	13.79
T ₂	13.26	12.90	13.76	14.13	16.58	14.13
T ₃	12.32	11.89	12.80	13.16	15.26	13.09
T ₄	12.89	12.17	13.06	13.54	15.72	13.48
T ₅	14.32	13.79	14.39	15.11	17.13	14.95
T ₆	15.61	14.56	15.28	16.06	18.41	15.98
T ₇	13.85	13.00	14.01	14.36	16.83	14.41

Table 3: Contd.,						
T₈	14.09	13.36	14.11	15.00	17.06	14.72
T₉	11.69	11.23	12.42	12.29	14.33	12.39
Mean	13.45	12.83	13.69	14.16	16.39	
	T		C		C x T	
SEd	0.53		0.58		0.65	
CD @ 5%	1.05		1.15		1.25	

The number of fruits and fruit weight were positively correlated with yield per plant. The number of fruits was highest in the chemical treatment T₆ - CaCl₂ (0.50 %) (32.10) and the lowest value were recorded in T₉ - Control (25.79). While in case of different cultivar treatments the highest value was recorded in C₄- US 6214 (33.64) and the lowest value was recorded in C₂. Co1 (19.65). Regarding the interaction between different chemical treatments and cultivars the highest fruit numbers was recorded in T₆ C₄ (T₆ - CaCl₂ (0.50 %), C₄ - US 6214 (36.71) and the lowest fruit numbers was recorded in T₉ C₂ (T₉ - Control, C₂- Co1) (17.61). The greater Ca content of unripe fruit might be explained by solute influx via the phloem, where Ca is known to be relatively immobile (Hanger, 1979). This influx increases with fruit development. Because of a lesser rate of cell division as the fruit mature, less binding sites for Ca are formed. Additionally, the volume : area ratio increases, which results in less transpiration per weight unit. These results are in line with the findings of Ferguson, (1984).

Table 4: Effect of Pre-Harvest Chemical Spray on Number of Fruits/ Vine of Bitter Gourd Cultivars

Treatments	Cultivars					
	C ₁	C ₂	C ₃	C ₄	C ₅	Mean
T₁	31.28	18.66	29.91	33.48	30.17	28.70
T₂	31.73	19.17	30.43	33.90	31.23	29.29
T₃	29.33	17.85	27.63	32.30	29.23	27.27
T₄	29.90	18.00	28.72	33.11	29.50	27.85
T₅	32.63	21.25	31.18	34.38	32.47	30.38
T₆	34.32	23.26	32.66	36.71	33.53	32.10
T₇	32.00	20.30	30.87	34.14	31.68	29.80
T₈	32.21	20.76	31.09	34.21	32.00	30.05
T₉	27.38	17.61	26.24	30.55	27.16	25.79
Mean	31.20	19.65	29.86	33.64	30.77	
	T		C		C x T	
SEd	0.91		0.85		1.17	
CD @ 5%	1.80		1.76		2.24	

Among the chemical treatments the highest fruit weight was recorded in T₆ - CaCl₂ (0.50 %) (187.01g) and the lowest value were recorded in the T₉ - Control (150.09g). Among the different cultivar treatments the highest fruit weight was recorded in C₅ - Palee (231.69 g) and the lowest value was recorded in C₁- Roma (146.96g). Considering interaction effects the highest fruit weight was recorded in T₆ C₅ (T₆ - CaCl₂ (0.50 %), C₅ - Palee) (255.92 g) and the lowest fruit numbers was recorded in T₉ C₁ (T₉ - Control, C₁ - Roma) (129.63 g). The presence of calcium in the form of calcium pectate in middle lamella of cell wall would have increased the individual fruit weight, which prevent loss of moisture from the fruits and ultimately yields better quality fruit. This phenomenon has been well studied by Subbiah (1994) in tomato. Calcium content of the fruit is associated with firmness of the fruit as a result of maintenance of turgidity of the fruit and fruit firmness and overall yield has increased due to the pre harvest foliar spray of 0.5 per cent CaCl₂ in okra Balasubramanian (2004).

Table 5: Effect of Pre-Harvest Chemical Spray on Fruit Weight (G) of Bitter Gourd Cultivars

Treatments	Cultivars					
	C ₁	C ₂	C ₃	C ₄	C ₅	Mean
T ₁	140.38	149.82	150.13	153.68	228.75	164.55
T ₂	145.23	150.27	152.46	158.34	230.16	167.29
T ₃	135.08	140.29	140.11	149.87	220.11	157.09
T ₄	139.23	147.61	146.28	150.28	222.83	161.25
T ₅	160.31	162.26	161.25	162.83	241.27	177.58
T ₆	168.47	172.82	165.16	172.66	255.92	187.01
T ₇	150.00	153.48	157.73	158.83	235.34	171.08
T ₈	154.35	158.93	160.01	160.17	239.66	174.62
T ₉	129.63	137.41	131.83	140.42	211.16	150.09
Mean	146.96	152.54	151.66	156.34	231.69	
	T		C		C x T	
SEd	5.28		7.87		7.81	
CD @ 5%	10.05		15.43		14.80	

The CaCl₂ 0.05 per cent spray registered significantly highest yield of T₆ - CaCl₂ (0.50 %) (6.02 kg/ vine) and the lowest yield was recorded in T₉ - Control (3.89 kg / vine). In case of cultivar treatments registered the highest yield was C₅ - Palee (7.15 kg / vine) and the lowest yield was recorded in C₂ - Co1 (3.02 kg / vine). Regarding interaction effect the highest yield per vine was recorded in T₆ C₅ (T₆ - CaCl₂ (0.50 %), C₅ - Palee) (8.58 kg / vine) and the lowest yield per vine was recorded in T₉ C₂ (T₉ - Control, C₂ - Co1) (2.42 kg / vine) there is some evidence that Ca can influence endogenous growth regulators (Bengerth, 1979) and effects such as increased cytokinin activity may result in thicker pericarp walls, since cytokinins have been associated with cell division and thickening in other plant organs (Leopold and Kriedeman, 1975). The potential effects of the chloride ion in these responses have been ruled out since prior work has shown that Ca ion is the active component in CaCl₂ treatment (Pooviah and Leopold, 1973). The high level of calcium present in fruits sprayed with CaCl₂ 0.5 per cent provides supporting evidence to confirm the role of calcium in increasing the fruit weight and yield. The earlier findings of Bharat Singh *et al.* (1998) in okra, Rahman and Shormeen (1999) in pumpkin, Vijay Kumar and Ray (2000) in cauliflower and Vijayaraghavan (2004) in bitter gourd lend credence to the present study.

Table 6: Effect of Pre-Harvest Chemical Spray on Yield / Vine (Kg) of Bitter Gourd Cultivars

Treatments	Cultivars					
	C ₁	C ₂	C ₃	C ₄	C ₅	Mean
T ₁	4.39	2.80	4.49	5.15	6.90	4.74
T ₂	4.61	2.88	4.64	5.37	7.19	4.94
T ₃	3.96	2.50	3.87	4.84	6.43	4.32
T ₄	4.16	2.66	4.20	4.98	6.57	4.51
T ₅	5.23	3.45	5.03	5.60	7.83	5.43
T ₆	5.78	4.02	5.39	6.34	8.58	6.02
T ₇	4.80	3.12	4.87	5.42	7.46	5.13
T ₈	4.97	3.30	4.97	5.48	7.67	5.28
T ₉	3.55	2.42	3.46	4.29	5.74	3.89
Mean	4.61	3.02	4.55	5.27	7.15	
	T		C		C x T	
SEd	0.17		0.13		0.31	
CD @ 5%	0.36		0.30		0.65	

CONCLUSIONS

Foliar application of preharvest Ca sprays to bitter gourd increased yield and yield attributes with increasing concentrations of preharvest sprays of CaCl_2 0.5 per cent produced the highest fruit length, fruit girth, number of fruits, fruit weight and yield. Regarding cultivars C₅- Palee followed by C₄- US 6214 produced the highest fruit weight and fruit yield / vine. These responses were associated with improved firmness retention in all the cultivars of bitter gourd. Water loss characteristics and initial fruit weight were not affected by Ca application. It appears that Ca sprays act to improve quality in bitter gourds in two ways: first by increasing pericarp wall thickness and non-water soluble pectic fractions of the cell walls and these promote firmness retention, and second by reducing the severity of postharvest decay.

REFERENCES

1. Aykroyd, W. R. (1963). The nutritive value of Indian foods and the planning's of satisfactory diets, special series No. 42. Indian Council of Medical Research, New Delhi, pp. 49-82.
2. Balasubramanian, P. (2004). Studies on the effect of pre and postharvest treatments on dehydration and storage of bhendivar. Arka anamika. M.Sc (Hort) Thesis. Tamil Nadu Agricultural University, Coimbatore.
3. Bangerth, F. (1979). Calcium – related physiological disorders of plants. *Ann. Rev. Phytopathol.* 17, 97-122.
4. Conway, W. S., Sams, C. E., McGuire, R. G & Kelman, A. (1992). Calcium treatment of apples and potatoes to reduce postharvest decay. *Plant Disease*. 76, 329-334.
5. Leopold, A. C & Kriedeman, P. E. (1975). Plant growth and development. 2nd ed. McGraw-Hill, Inc., New York, NY. 545.
6. Pooviah, B. W & Leopold, A. C. (1973). Defferel of leaf senescence with calcium. *Plant Physiol.* 52, 236-239.
7. Ferguson, L. B. (1984). Calcium in plant senescence and fruit ripening. *Plant Cell Environ.* 7, 477-489.
8. Hanger, B. C. (1979). The movement of calcium in plants. *Commun. Soil Sci. Plant Anal.* 10, 171-193.
9. Grover, J. K. & Yadav. S. P. (2004). Pharmacological action and potential uses of *Momordica charantia* L. *J. Ethnopharmacol.* 93 (1), 123-132.
10. Katwale T. R & Saraf R. K. (1990). Effect of growth regulators and urea spray on the growth and yield of chilli (*Capsicum annunn* L.) *Orissa J. Hort.* 18, 52–56.
11. Lotlikar, M. M & Rajaramrao, M. R. (1966). Pharmacology of a hypoglycemic principal isolated from the fruits of *Momordica charantia* L. *Indian. J. Pharm.*, 28,129.
12. Ouzounidou. G, Papadopoulou. P, Giannakoula. A & Ilias. I. (2008). Plant growth regulators treatments modulate growth, physiology and quality characteristics of *Cucumis melo* L., plants. *Pak. J. Bot.*, 40, 1185-1193.
13. Rahman, M. A & Shoremen. S. (1999). Effect of IAA, GA₃, TIBA, B and M₀ on sex expression and yield of *Cucurbita moschata*, *Bangladesh J. Bot.*, 28(1), 79-83.
14. Subbiah, K & Rani Perumal. (1994). Pectin and Ascorbic acid content in tomatoes as influenced by the graded doses of N, K and CaCl_2 sprays. *Madras Agri. J.*, 81(4), 227-229.

15. Subbiah, K. (1994). Firmness index of tomato as influenced by added N, K, and CaCl_2 sprays. *Madras Agri. J.*, 81(1), 32-33.
16. TNAU Crop Production Guide (2013). http://www.agritech.tnau.ac.in/pdf/2013/cpg_horti_2013.pdf.
17. Vijayaraghavan, V. (2004). Studies on pre and postharvest treatments on dehydration and storage of bitter gourd cv. CO1. M.Sc (Hort) Thesis. Tamil Nadu Agricultural University, Coimbatore.
18. Toivonen, P. M. A. & Bowen, P. A. (1999). The effect of preharvest foliar sprays of calcium on quality and shelf life of two cultivars of sweet bell peppers (*Capsicum annuum* L.) grown in plasticulture. *Can. J. Plant Sci.* 79, 411–416.
19. Bharat Singh, I. S. Naruka & Laxman Singh. (1998). Effect of foliar application of nitrogen (Urea) and gibberellic acid (GA_3) on growth and yield of okra (*Abelmoschus esculentus* (L.) Moench) cv Pusa Sawani. *Prog. Hort.*, 30 (3-4), 175-180.
20. Vijay Kumar & Ray. N. (2000). Effect of plant growth regulators on cauliflower cv. Pant Subhra. *Orissa J. Hort.*, 28 (1), 65-67.

